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The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water

WRITE-UP 5: TRAFFIC IMPACE ASSESSMENT

FINAL

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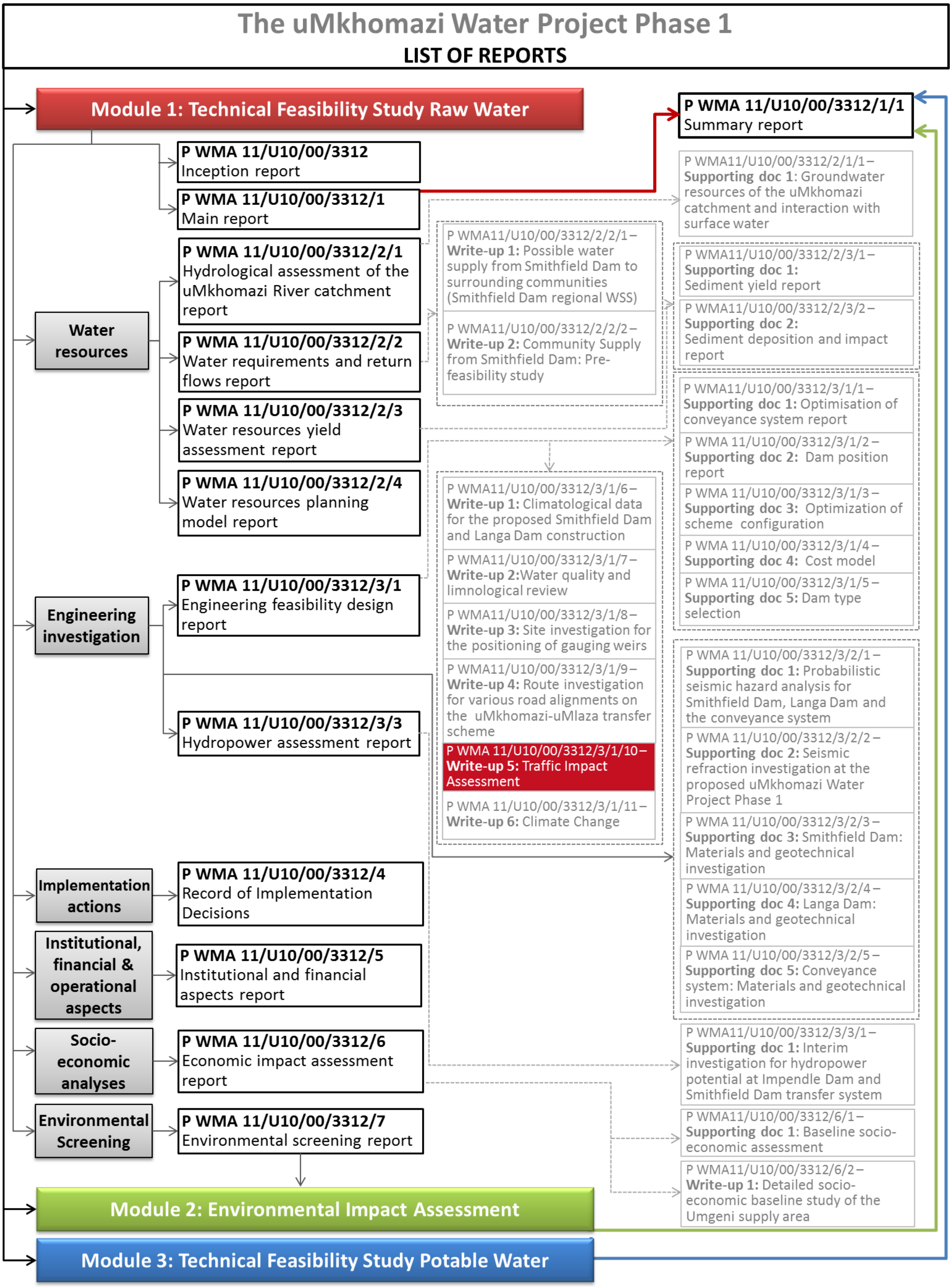
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LIST OF ABBREVIATIONS

%HV	Percentage heavy vehicles
%OLOG	% Overloaded Over Grace
%XE80	Percentage Extra E80
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
ADLT	Average Daily Light Traffic
CTO	Comprehensive Traffic Observation
E80	Equivalent Standard Axle of 80kN
E80/HV	E80 per Heavy Vehicle
EMP	Environmental Management Plan
IAP's	Interested and Affected Parties
KZN DoT	Kwazulu-Natal Department of Transport
LOS	Level-of-Service
N3TC	N3 Toll Concession Pty Ltd
SANRAL	South-African National Roads Agency SOC Ltd
TBM	Tunnel Boring Machine
TIA	Traffic Impact Assessment
TT-Method	Truck Tractor Method
uMWP	uMkhomazi Water Project
uMWP - 1	uMkhomazi Water Project Phase 1
V/C	Volume over Capacity Ratio
WIM	Weigh-in-motion

1 INTRODUCTION

1.1 BACKGROUND

AECOM SA (Pty) Ltd. was appointed by the Department of Water Affairs to conduct the traffic impact assessment (TIA), as part of the environmental impact assessment (EIA) process, for both the raw water and potable water infrastructure of the uMkhomazi Water Project Phase 1 (uMWP-1). The key infrastructure components are summarised below:

1. Raw Water Infrastructure:
   - Smithfield retaining Dam;
   - Langa balancing Dam;
   - uMkhomazi to uMlaza conveyance tunnel; and
   - Raw Water Pipeline from the tunnel outlet to the Bayensfield Water Treatment Plant, including an extension to Langa Dam.
2. Potable Water Infrastructure:
   - Water Treatment Plant; and
   - Potable Water Pipeline from the Water Treatment Plant to the Reservoir

The raw water infrastructure will be owned by the Department of Water Affairs and the potable water infrastructure by Umgeni Water.

1.2 OBJECTIVES OF INVESTIGATION

The following goals were pursued:

- Determine the traffic impact during the construction and operational phases of the uMWP-1.
- Provide feasible measures to mitigate the traffic impact of the project on the surrounding road network to acceptable levels.
- Give recommendations on how adherence to the Environmental Management Plan (EMP), pertaining to traffic, may be enforced and monitored.

1.3 STUDY AREA

The study area is divided into three key activity nodes (see **Figure 1)**:

- The Smithfield node is located next to the R617, approximately 38km south-west of the Howick/Underberg interchange. This node will include the Smithfield dam, construction of access roads and realignment of a short portion of the R617 around the impounded area.
- The Langa node is located just south of Thornville at the Baynesfield Estate, roughly 20km south of Pietermaritzburg along the R56. This node includes the Langa dam, Water Treatment Plant and the raw and potable water pipe lines.
- The Mafunze node is located about halfway between the Smithfield and Langa nodes along the tunnel route, in anticipation that the contractor would choose to use two tunnel boring machines (TBM) to drill the tunnel in 2 sections – one from Langa to Mafunze and another from Mafunze to Smithfield.

Specific attention was given to:

- Locations where access routes intersect with the R617 and R56.
- Possible pipeline crossing locations along the R56.
- Sensitive areas (e.g. residential settlements, schools, Baynesfield Estate) in close proximity to the routes affected by the project.
- Deviation of existing routes around the flood lines.

2 METHODOLOGY

The following methodology was used:

a) Traffic Data Collection

- The latest available electronic traffic counts from permanent comprehensive traffic observation (CTO) stations were obtained.
- Traffic data from ad hoc electronic traffic counts conducted in 2011 and 2012 were obtained.
- 12-Hour classified manual traffic counts were conducted at 5 critical intersections on a normal weekday. The locations are illustrated on **Figure 2**.

b) Road Network

- The locations of the proposed access roads to the uMWP-1 sites were obtained.
- An assessment of the regional and local road network as well as the proposed access roads was done. The following were taken into consideration:
  - Road function and hierarchy;
  - Deviation of existing routes around the flood lines;
  - Closing of existing roads owing to impoundment;
  - Access route locations;
  - Proposed access road layouts;
  - Intersection capacity and safety;
  - Sight-distance restrictions;
  - Proposed intersection control;
  - Pedestrian crossings; and
  - Speed limits.

c) Calculation of Expected Vehicle Trip Generation

- The expected trip generation for the construction and operation phases of the projects were calculated.
- Heavy vehicle trips were calculated based on the expected tonnage of construction material to be transported via the external road network and access routes.
- The trip generation for the operation phase was calculated based on the stipulated requirements.

d) Evaluation of Traffic Impact

- An evaluation was done to determine the impact of the additional vehicle trips on the surrounding road network.
- The construction phase and operational phase were evaluated separately.
- The evaluation covered the following aspects:
  - Traffic volume increase;
  - Duration of impact;
  - Sensitive locations (e.g. schools);
  - Suitability of road geometry, for heavy vehicles in particular;
  - Road bearing capacity vs pavement loading (high level);
  - Overloading of heavy vehicles;
  - Speeding and impact on road safety;
  - Redistribution of traffic onto altered road network;
  - Available traffic capacity;
  - Impact on local communities; and
  - Road safety.

e) Development of Mitigation Measures

- Where required, recommendations for measures to mitigate the traffic impact of the project on the surrounding road network to acceptable levels were made.
- The proposed mitigation measures should form part of the EMP.

f) Public Participation and Liaison

- Technical support pertaining to traffic will be provided during the public participation process.

g) Adherence to Environmental Management Plan (EMP)

- Recommendations were made on the mitigation measures to be included in the EMP, which includes monitoring processes to ensure that such measures are implemented satisfactorily.

3 TRAFFIC DATA COLLECTION

3.1 ELECTRONIC TRAFFIC DATA COLLECTION

Permanent CTO stations are located on the R617 (CTO 1264) and R56 (CTO 1106) – see **Figure 4**. These stations provide historical traffic volume data as well as heavy vehicle loading information. The stations were both operational from 2006 to date.

Ad hoc electronic counts were conducted for KZN DoT at 10 locations on the R617 and 6 locations on the R56. This was done over approximately a 1 week period in either 2011 or 2012. The locations are indicated on **Figure 4**.

3.2 MANUAL TRAFFIC AND PEDESTRIAN SURVEYS

12-Hour classified manual traffic surveys were conducted at 5 critical intersections on a normal weekday (10 March 2015). The counts were classified into light vehicle, heavy vehicle, bus and minibus taxi. Pedestrian and cyclist counts were also conducted. The critical intersections are listed below and the positions are indicated on **Figure 2**.

1. R617 / Smithfield Main Dam Embankment Access Road
2. R617 / Mdayane Access Road
3. R617 / Nonguqa Access Road (D1212)
4. R56 / P334
5. R56 / Baynesfield 2

These intersections were considered to be critical because:

- Intersection 1 will be the main entry point for construction vehicles to the main embankment of Smithfield dam from the R617.
- Intersection 2 and 3 will be influenced by the deviation of the R617.
- Intersection 4 and 5 will be the main entry points for construction vehicles to the Langa dam site from the R56.

4 Traffic Status Quo

4.1 Road Network

The main routes affected by traffic generated by the uMWP-1 are sections of the N3, R617 and R56 as well as some smaller local access roads.

The main impact will be on the provincial routes R617 and R56. Both the R617 and R56 currently comprise of one lane per direction with occasional passing lanes. The Smithfield and Langa dam basins are located in a valley area. As the R617 and R56 approach the dam sites the roads stretch across rolling terrain winding along the contours with limiting sight distances on some sections. The speed limits on these roads vary between 80 and 100 km/h.

The 5 critical intersections identified in **Section 3.2** are currently all 1-way stop controlled with free flow on the R617 and R56.

4.2 Traffic Volume and Composition

The background traffic volumes and traffic composition (i.e. without the uMWP-1 construction and operation traffic) were determined for the R617 and R56 using the electronic counts and 12-hour manual traffic surveys.

The link traffic volumes (average daily traffic (ADT) and annual daily truck traffic (ADTT)) from the permanent CTO stations and the ad-hoc electronic counts are summarised on **Figure 4**.

The northern sections of the R617 and R56 have commuter characteristics whereas rural conditions prevail towards the south. On the R617 there is commuter travel on the section between Howick and Mpophomeni and on the R56 between Pietermaritzburg and Richmond. This is evident from the traffic profile indicating morning and afternoon peaks as well as the higher volume of light vehicle traffic on these sections. The ADT on the R617 ranges from ±7 800 vehicles close to Howick to ±2 000 vehicles close to Smithfield dam. The ADTT on the R617 is fairly constant ranging between 400 to 600 vehicles. The ADT on the R56 is fairly constant ranging from ±6 500 vehicles close to Pietermaritzburg to ±6 200 vehicles close to Langa dam. The ADTT on the R56 is fairly constant ranging between 600 to 800 vehicles. A summary of the link traffic volumes is provided in **Table 4-1** below:

Table 4-1: Link Traffic Volumes on the R617 and R56

Route	ADT	ADTT
R617	±2000 - 7800	±400 - 600
R56	±6200 - 6500	±600 - 800

The traffic volumes recorded during the 12-hour manual traffic surveys are illustrated on **Figure 5**. It can be seen from the traffic surveys that very low turning volumes are present at the 5 intersections.

The following average traffic composition was observed at the 5 critical intersections:

Table 4-2: Traffic Composition (12 hour manual traffic surveys)

Mode	Percentage of Total
Light Vehicle	79.3%
Heavy Vehicle	14.7%
Bus	5.5%
Minibus taxi	0.5%
Total	**100%**

4.3 Pedestrians and Cyclists

The pedestrian and cyclist volumes were also recorded during the 12 hour manual traffic surveys at the 5 critical intersections. A summary of the volumes over the 12 hour period for all directions is provided in the table below:

Table 4-3: 12 Hour Pedestrian and Cyclist Volumes

Intersection		12-Hour Count	
		Pedestrian	Cyclist
1	R617 / Access Road to Smithfield Main Dam Embankment	26	-
2	R617 / Mdayane Access Rd	33	-
3	R617 / Nonguqa Access Road (D1212)	100	2
4	R56 / P334	16	8
5	R56 / Baynesfield 2	12	3

Low pedestrian and cyclist volumes were recorded at all of the intersections with the exception of the intersection of the R617 with the Nonguqa Access Road (D1212) where slightly higher volumes were recorded. 63 of the 100 pedestrians counted over the 12-hour period crossed over the R617.

4.4 Heavy Vehicle Loading

The pavement condition of the R617 is generally good, but ageing with localised deformation. The R56 pavement condition is generally good.

Loading data is available from the two WIM stations located on the R617 and R56 respectively. According to the ad hoc 2011 and 2012 electronic counts the annual daily truck traffic (ADTT) is fairly consistent over the road sections investigated, hence the two routes were treated as homogeneous pavement loading sections.

The SANRAL-endorsed Truck Tractor (TT) Method[ref 1] is used to calibrate loading data from WIM systems in retrospect. A series of data quality checks have been designed together with the TT Method, and they are used as warning signs to indicate when loading data becomes unstable or unacceptable.

The quality checks based on the Truck Tractor (TT) Method were applied in order to determine the quality of the available WIM data. Only the following two requirements were not met:

- At CTO 1264 vehicle lane discipline is problematic (>10% of heavy vehicles clip the WIM sensor resulting in partial weighs).
- At CTO 1106 random WIM measurement error (scatter) is above acceptable norms (the standard deviation of truck tractors of heavily loaded 6-axle and 7-axle trucks is above the 2.0 ton threshold).

Despite the above mentioned issues the WIM data provides a reasonable high-level estimate of heavy vehicle loading for the purpose of this investigation. The loading data is summarised in the table below:

Table 4-4: Pavement Loading (2014)

Route	Station	Direction	ADTT	%HV	Short	Medium	Long	%OLOG	E80/HV
R617	1264	NB	280	7.2%	49%	32%	19%	4.8	0.96
		SB	292	7.5%	49%	32%	19%	7.1	1.06
R56	1106	NB	305	9.3%	65%	19%	16%	9.3	1.05
		SB	284	8.7%	65%	19%	16%	10.4	1.33

ADTT – annual daily truck traffic, %HV – % heavy vehicles, %OLOG - % heavy vehicles overloaded over grace, E80/HV – average E80s per heavy vehicle.

On both roads the northbound and southbound heavy vehicle traffic composition is fairly similar. Less than 20% of the heavy vehicles are long (>17m) which suggest that neither of these routes have heavy freight carrying characteristics.

It should be noted that well-calibrated WIMs over-estimate the percentage of overloaded HVs because the random measurement error committed by the WIM results in a widened axle load distribution. The %OLOG given in the table may therefore be considered to be conservative upper limits.

In order to quantify pavement damage caused by heavy vehicles a standard axle load of 80kN is used, one 80kN axle causes one unit of road damage (one E80). Damage caused by any other axle load is expressed in terms of equivalent standard axle loads (ESALs or E80s) using the formula:

$$E80 = \left(\frac{W}{8.2}\right)^n$$

Where:

E80 = Number of equivalent standard axles
W = Axle load in tons
N = Damage exponent, 4,2

The average E80s per heavy vehicle (E80/HV) calculated for the R617 and R56 are realistic for rural routes with no industry hubs located along the route.

5 Proposed Access Routes and Road Alterations

5.1 Locations of Construction Activity

uMWP-1 related vehicles trips will be made to/from and also between the following locations of construction activity:

- Raw Water Infrastructure
  - Smithfield dam - Access Roads;
  - Langa dam - Access Roads;
  - Smithfield dam and Tunnel inlet (western half);
  - Langa dam, Tunnel outlet (eastern half) and Raw Water Pipeline;
  - R617 deviation;
  - Smithfield dam to R617 Deviation; and
  - Between Smithfield dam and Tunnel (western half).
- Potable Water Infrastructure
  - Water Treatment Plant;
  - Potable Water Pipeline (R56); and
  - Potable Water Pipeline (R603).

The above mentioned locations will be used as delivery hubs for construction material etc.

5.2 Access Routes to Construction Locations

Access will be provided via the following routes (see **Figure 2 and 3**):

- Langa Dam Access Road;
- Smithfield Main Embankment Access Road;
- Tunnel Midway Access Road; and
- Water Treatment Plant Option 1, 2 and 3.

The design parameters for the construction access routes were as follows:

- 40km/h design speed;
- Minimum horizontal curve radius of 60m; and
- 4m wide lanes.

No heavy construction vehicles are allowed using the access road from the R617 to Ncwadi.

The access roads and their intersections with the R617 and R56 will be influenced by the traffic generated by the uMWP-1. The impact is investigated in **Section 7**.

Deviations around the Smithfield dam flood lines will be required at the following routes (see **Figure 2**):

- Smithfield Main Embankment Access Road deviation;
- Nonguqa Access Road deviation; and
- R617 deviation.

A comparison of the old and new travelling distances is shown in **Table 5-1**.

Table 5-1: Route Deviation Travelling Distances

Route	Existing distance	Deviation distance	Difference
Smithfield Main Embankment Access Road	3.96 km	4.15 km	0.19 km
Nonguqa Access Road deviation	5.69 km	6.31 km	0.62 km
R617 deviation	8.56 km	12.06 km	3.50 km

The deviation of these routes will not cause redistribution of traffic onto other routes.

One road will be cut off by the inundation, viz. the access road that crosses the river at the Lundy's Hill Supply Store (about 1.4 km west of the Smithfield main embankment access road intersection). People residing south of the river would lose this direct access to the R617, and would have to travel around the western side of the dam. For people wanting to travel north-east on R617, the detour around the dam will add as much as 14 km to their travel distance.

The expected road surfacing and road width for the access and deviated routes are summarised in **Table 5-2** below.

Table 5-2: Profile of Access Roads and Deviations

Route	Final Layer	Cross Section
Langa dam Access Road	Paved	8m (4m lanes)
Smithfield Main Embankment Access Road	Paved	8m (4m lanes)
Tunnel Midway Access Road	Gravel	8m (4m lanes)
Smithfield Main Embankment Access Road deviation	Paved	8m (4m lanes)
Nonguqa Access Road deviation	Gravel	8m (4m lanes)
R617 deviation	Paved	9m (3.5m lanes with 1m shoulder)

6 TRIP GENERATION

6.1 CONSTRUCTION PHASE

The trip generation calculations were based on the latest available (feasibility stage) information of the uMWP-1. Final quantities, construction method and program information will only be available later and therefore realistic assumptions were made regarding:

- Required construction material quantities;
- Construction material sources;
- Construction programme; and
- Required workforce.

The trip generation calculations described below are considered to be reasonable estimates and are adequate to determine the traffic impact for planning purposes. Calculations should be refined for critical road infrastructure elements if more accurate construction information in future suggests that certain impacts may have been underestimated.

6.1.1 Workforce Vehicle Trips

The workforce vehicle trips apply to all persons employed by the uMWP-1. It is anticipated that a construction camp will be provided on site for the construction workers (skilled staff). The critical vehicle trip generation period will be when the skilled staff residing in the construction camp leave site on the last Friday of the month. The local labour and professional staff will generate trips during the AM and PM peak throughout the month which will coincide with the strong peak generated by skilled staff on the last Friday of the month.

It is anticipated that the weekday AM peak and Friday end of the month PM peak will be the most critical peaks. The number of vehicle trips generated during these peaks was calculated based on the following:

- Estimated number of local labour, skilled staff and professional staff per site:

Table 6-1: Construction Phase – Estimated Workforce

uMWP-1 Component	Local Labour	Skilled Staff	Professional Staff
Raw Water Infrastructure	4 700	500	100
Potable Water Infrastructure	2 260	240	50

- The construction of the tunnel, connecting Smithfield dam to Langa dam, will continue 24 hours a day. The workforce will be divided into 2 or 3 shifts per day. The most critical case was considered, assuming 2 shifts with a shift change during the AM and PM peak periods. It was additionally assumed that the arriving and departing workforce do not use the same buses.
- A modal split was assumed between busses, minibus taxis and light vehicles:

Table 6-2: Construction Phase – Assumed Workforce Modal Split

Workforce	Bus	Minibus taxi	Light Vehicle
Local Labour	80%	20%	0%
Skilled staff	40%	60%	0%
Professional staff	0%	0%	100%

- The assumed vehicle occupancies are 45 persons per bus, 12 per minibus taxi and 2 per light vehicle.
- It was conservatively assumed that all busses and minibus taxis will make a trip to and from site within one hour. This implies a trip rate of 2 trips per vehicle per hour.
- Light vehicles will travel to site during the AM peak hour and from site during the PM peak hour. This implies a trip rate of 1 trip per vehicle per hour.

The number of vehicle trips were calculated based on the above assumptions and are summarised in **Table 6-3** below.

Table 6-3: Construction Phase – AM and PM Peak Workforce Vehicle Trips

uMWP-1 Component	Bus	Minibus taxi	Light Vehicle
Weekday AM Peak Hour			
Raw Water Infrastructure Project	169	159	52
Potable Water Infrastructure Project	82	76	25
Month-end Friday PM Peak			
Raw Water Infrastructure Project	179	208	52
Potable Water Infrastructure Project	86	100	25

Two-directional trips

It was further assumed that the workforce will be travelling to and from Pietermaritzburg. This is considered to be conservative as local labour is expected to reside in settlements closer to site with a traffic impact limited to a smaller part of the road network.

6.1.2 Heavy Vehicle Delivery Trips

The heavy vehicle trip generation is split between importing of construction material and the transport of material between sites.

Imported Material

It is expected that a high proportion of the construction material will be sourced from the dam basins and tunnel. This will drastically reduce the required construction material to be imported to site. Imported material from commercial sources will mainly consist of the elements shown in **Table 6-4** below:

Table 6-4: Expected Construction Material Sources

Construction Material	Assumed Source
Cement	Commercial source in Pietermaritzburg
Sand	Umkomaas river mouth
Reinforcement	Commercial source in Pietermaritzburg
Aggregate	Commercial quarries: Midmar Crushers and Natal Crushers
Pipes and Valves	Commercial source in Vereeniging

Transported Material

It is expected that the following construction and excavated material will be transported between sites:

- Aggregate will be transported from the borrow pits at Smithfield dam for the construction of the R617 deviation.
- Two tunnel boring machines (TBM) will be used for the excavation of the tunnel. It is assumed that the one will enter at the Langa dam site tunnelling westwards. The second will enter near Mafunze in the middle of the tunnel tunnelling westwards toward Smithfield dam. The positions are indicated on **Figure 2**. The tunnel is thus divided in an eastern and western half.
- The material excavated from the western half of the tunnel will be transported to a spoil site located near the middle of the tunnel where the TBM entered. The material excavated from the eastern half of the tunnel will be transported to a spoil site at Langa dam. The connecting routes are on-site and no significant trips will thus be generated on the external road network.
- The rock bolts for the western half of the tunnel will be transported from the Smithfield dam site.
- The rock bolts for the eastern half of the tunnel will be transported from the Langa dam site via roads within the construction site and no trips will be added to the external road network.
- The precast concrete lining of the western half of the tunnel will be transported from the precast yard at Smithfield dam.
- The precast concrete lining of the eastern half of the tunnel will be transported from the precast yard at Langa dam via roads within the construction site and no trips will be added to the external road network.

The construction material quantities to be imported to site and transported between sites were based on the provisional (feasibility stage) bill of quantities. The quantities are listed in **Table 6-5** according to the delivery hubs (as defined in **Section 5**) of the Raw Water and Potable Water projects.

Table 6-5: Imported and Transported Construction Material Quantities

Project and Delivery hubs		Construction Material				
		Sand (m^3)	Aggregate (m^3)	Cement (m^3)	Reinforcement (t)	Pipe (m)
Raw Water Infrastructure Project						
Imported Material	Smithfield dam - Access Roads		27 000			
	Langa dam - Access Roads		71 000			
	Smithfield dam & Tunnel (western half)	253 000		34 000	22 000	
	Langa dam, Tunnel (eastern half) & Raw Water Pipeline	44 000	246 000	18 000	9 000	5 000
	R617 deviation		18 000			
Transported Material	Smithfield dam to R617 Deviation		52 000			
	Between Smithfield dam and Tunnel (western half)	29 000	35 000	12 000	5 000	
Potable Water Infrastructure Project						
Imported Material	Water Treatment Plant	101 000	66 000	21 000	10 000	
	Potable Water Pipeline (R56)	97 000				11 000
	Potable Water Pipeline (R603)	97 000				11 000

The expected delivery periods were determined based on the anticipated construction programme and are listed below:

Table 6-6: Construction Phase – Delivery Periods

uMWP-1	Start Date	Completion Date	Duration
Raw Water Infrastructure Project			
Smithfield dam - Access Roads	Oct 2018	Dec 2018	3 months
Langa dam - Access Roads	Oct 2018	Dec 2018	3 months
Smithfield dam & Tunnel (western half)	Oct 2018	May 2022	44 months
Langa dam, Tunnel (eastern half) & Raw Water Pipeline	Apr 2019	Jun 2022	39 months
R617 deviation	Jul 2019	Dec 2020	18 months
Smithfield dam to R617 Deviation	Jul 2019	Dec 2020	18 months
Between Smithfield dam and Tunnel (western half)	Nov 2019	Feb 2022	28 months
Between Langa dam and Tunnel (eastern half)	Nov 2019	Jun 2022	32 months
Potable Water Infrastructure Project			
Water Treatment Plant	Apr 2019	Jun 2023	51 months
Potable Water Pipeline (R56)	Jan 2020	Dec 2021	24 months
Potable Water Pipeline (R603)	Jan 2020	Dec 2021	24 months

The following principles were applied in order to calculate the expected daily heavy vehicle trips:

- Construction material will be transported on weekdays only. An average of 22 working days per month was assumed.
- Each construction period was divided into 3 phases to account for fluctuations in delivery of construction material. It was assumed that the trip generation during the peak construction period (70% of the duration) will be 20% higher than the average trip generation. The trip generation during the start-up and close-down (first and last 15% of the construction period) was reduced accordingly.
- The construction material quantities were converted to tonnage using the material densities (see **Appendix A**). The tonnages and typical payload capacities of trucks were used to estimate the number of deliveries. The transportation of pipes is an exception as loading of pipes onto trucks is generally limited by length and diameter as opposed to mass.
- An efficiently loaded 7-axle truck can transport approximately 35t payload and a 6-axle truck approximately 30t payload. Depending on the type of load some trucks cannot be loaded efficiently, with payloads reducing to 25t. It is, therefore, realistically expected that an overall average payload of 30t will be achieved for the transportation of construction material.

- A 6-axle truck can transport a total pipe length of 12 m.
- Focus was placed on the main components of the construction material that resemble the bulk of the imported construction material. Exact details about the volume, and in particular the type of trucks on which other construction materials and equipment will be delivered is not available. The heavy vehicle trips were increased by 20% in order to account for these un-specified loads.
- The trip calculations are based on an average day during the peak construction period. It was assumed that on a critical day within the peak period the heavy vehicle trips will be double that of an average day to account for supply fluctuations.

The heavy vehicle deliveries for a critical day in the peak construction period were calculated by applying the principles discussed above. The maximum total trips generated in any period during a year is summarised in **Table 6-7** below. The total combined trip generation is considered to be conservative since it assumes the simultaneous occurrence of the worst-case trip generation for all overlapping construction processes.

Table 6-7: Construction Phase – Daily Heavy Vehicle Delivery Trips (one-directional)

Project and Delivery hubs		R617						R56						Other (Langa dam Access Rd, R603)*					
		2018	2019	2020	2021	2022	2023	2018	2019	2020	2021	2022	2023	2018	2019	2020	2021	2022	2023
Raw Water Infrastructure Project																			
Imported Material	Smithfield dam - Access Roads	50																	
	Langa dam - Access Roads							130						130					
	Smithfield dam & Tunnel (western half)	18	44	44	44	18													
	Langa dam, Tunnel (eastern half) & Raw Water Pipeline								54	54	54	54			54	54	54	54	
	R617 deviation		8	8															
Transported Material	Smithfield dam to R617 Deviation		20	20															
	Between Smithfield dam and Tunnel (western half)		8	20	20	8													
Raw Water - TOTAL		**68**	**80**	**92**	**64**	**26**	**0**	**130**	**54**	**54**	**54**	**54**	**0**	**130**	**54**	**54**	**54**	**54**	**0**
Potable Water Infrastructure Project																			
Imported Material	Water Treatment Plant								26	26	26	26	10						
	Potable Water Pipeline (R56)									13	13								
	Potable Water Pipeline (R603)															13	13		
Potable Water - TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**40**	**40**	**26**	**10**	**0**	**0**	**14**	**14**	**0**	**0**

One-directional trips

** The Raw Water – TOTAL under Other is applicable to Langa dam Access Road. The Potable Water – TOTAL under Other is applicable to the R603*

6.1.3 Abnormal Heavy Vehicle Loads

Some abnormal loads will have to be transported to / from site. Most of these loads will be transported at the beginning and end of the construction period. These include temporary offices, lifting equipment and heavy machinery such as a tunnel boring machine (TBM). The exact number of these heavy vehicles is not certain, but it is negligible compared to the number of normal heavy vehicles. The focus in dealing with these loads is therefore their dimensions or weight as opposed to their quantities.

According to the uMWP-1 timeframes two TBM's will be mobilized in September 2018. The deployment locations are marked on **Figure 2**. Location 1 has two key limiting factors; passing through the settlement areas and the undesirable topography.

Abnormal load permits will be required for transporting abnormal loads which will include a route determination to ensure that they can be transported safely on the available routes. Such permits are issued on a case by case basis. No detailed assessments are therefore required as part of this study.

6.2 Operational Phase

Permanent access routes are provided to all the uMWP-1 sites. Vehicle trips will be generated owing to the following:

1. Employees travelling to and from work;
2. Sludge removal at the Water Treatment Plant; and
3. Delivery of chemicals at the Water Treatment Plant.

The vehicle trip generation was done based on estimated employee numbers as well as a report done by Knight Piésold Report[ref 3] for the Conceptual Design and Cost Estimates of the Water Treatment Plant (only phase 1 of the Water Treatment Plant will be constructed as part of the uMWP-1). The report contains the Water Treatment Plant employee numbers, expected sludge quantities and required volumes of chemicals.

Employees

Vehicle trips will be generated by employees travelling to and from work during the weekday AM and PM peak hours. The trip generation for the Water Treatment

Plant employees was done separately as the plant operates 24 hours a day and will involve shift changes.

The expected employee numbers for Smithfield dam, the Tunnel, Langa dam and the raw and potable water pipelines were estimated and are summarised in **Table 6-8**.

Table 6-8: Operational Phase – Estimated Employee Numbers

uMWP-1	Local Labour	Skilled Staff	Professional Staff
Raw Water Infrastructure	115	15	5
Potable Water Infrastructure [#1]	10	5	1

#1 The Water Treatment Plant is not included

The numbers of vehicle trips generated by these employees during AM and PM peaks were calculated based on the following:

- A modal split was assumed between busses, minibus taxis and light vehicles:

Table 6-9: Operational Phase – Employee Modal Split

Workforce	Bus	Minibus taxi	Light Vehicle
Local Labour	80%	20%	0%
Skilled staff	40%	60%	0%
Professional staff	0%	0%	100%

- The assumed vehicle occupancy was assumed as 20 persons per bus, 6 per minibus taxi and 1 per light vehicle.
- It was conservatively assumed that all busses and minibus taxis will make a trip to and from site in one hour. This implies a trip rate of 2 trips per vehicle per hour.
- Light vehicles will travel to site during the AM peak hour and from site during the PM peak hour. This implies a trip rate of 1 trip per vehicle per hour.

The expected number of employees for the Water Treatment Plant was based on the report by Knight Piésold[ref 3]. It is foreseen that for phase 1 the Water Treatment Plant will require a total of 49 employees. The total number of employees includes provision for shift work for continuous (24 hour per day) plant operation. During a shift change incoming and outgoing trips will be generated. The number of vehicle trips generated by these employees during AM and PM peaks was calculated based on the following:

- A directional split of 40:60.

- A modal choice of 40% private vehicles with a passenger occupancy of 1.0 and 60% minibus taxis with a passenger occupancy of 4.0.
- 100% of the vehicle trips will be generated during the AM and PM peak hour.

The combined vehicle trip generation was calculated and is summarised in the table below:

Table 6-10: Operational Phase – AM and PM Peak Employee Vehicle Trips

uMWP-1	Bus	Minibus taxi	Light Vehicle
Weekday AM Peak Hour			
Raw Water Infrastructure Project	12	12	5
Potable Water Infrastructure Project	6	13	21
Weekday PM Peak Hour			
Raw Water Infrastructure Project	12	12	5
Potable Water Infrastructure Project	6	13	21

Two-directional trips

Of the total trips generated only 7 taxi and 20 light vehicle trips are generated by the Water Treatment Plant during the AM and PM peak hour.

Sludge Removal

The following was assumed regarding sludge removal at the water treatment plant based on the most recent information from Umgeni Water:

- It is expected that on a daily basis a maximum of 13 t of sludge will be produced.
- The sludge will be transported to a local landfill site using two trucks.

It was further assumed that the sludge removal would not take place during the AM and PM peaks. From a traffic perspective the sludge removal will have a negligible impact on the road network.

Delivery of Chemicals

Various chemicals are required for operation of the Water Treatment Plant. According to the conceptual design(ref 3) a total of 7 430 t chemicals will be required annually for phase 1 of the Water Treatment Plant. This amounts to a usage of approximately 21 t of chemicals on a daily basis. Assuming that delivery will only take place on week days (22 working days in a month) a minimum average daily delivery of 29 t is required. Various chemicals will be delivered and therefore a smaller average payload of 20 t was used. Based on the daily delivery requirements and a 20 t payload, 2 truckloads are required. It was also taken into account that the various chemicals will be delivered separately. On a critical day is it therefore expected that a maximum of 4 truckloads (one-way) will be delivered to the Water Treatment Plant. It was further assumed that one heavy vehicle delivery will take place during the AM and PM peak.

7 EVALUATION OF TRAFFIC IMPACT

7.1 INCREASE IN EXISTING TRAFFIC VOLUMES

In this chapter a comparison is drawn between the existing traffic volumes on the road, referred to as the background traffic, and the traffic generated by the uMWP-1 during the construction and operation phases.

It is expected that the collective construction period will run from 2018 to 2023, with operation starting in 2024. Based on the combined trip generation the most critical year during the construction period was identified as 2020 when the highest number of vehicle trips will be generated.

The historical average annual traffic growth rate was determined using the traffic data recorded by CTO 1264 and CTO 1106. Based on these traffic growth rates a realistic estimation of 3% annual traffic growth was assumed. The growth rate was applied to determine the representative future background traffic volumes. The average daily light traffic (ADLT) varies substantially along the R617 and R56, therefore background traffic volumes from the permanent CTO station along with an ad-hoc station were used to determine the background traffic volumes.

7.1.1 Construction Phase

The number of vehicle trips generated by the uMWP-1 during the construction phase (2020) in relation to the background traffic on the road is given below:

Table 7-1: Construction Phase – Peak Traffic Volume Increase (2020)

uMWP-1	Location	Description	Background Traffic Volume, per day (two-way)	uMWP-1 Construction Traffic, per day (two-way)	Percentage Increase
Raw Water Infrastructure	R617 at CTO 1264	ADT	9 292	316	3.4%
		ADLT	8 609	158	1.8%
		ADTT	683	158	23.1%
	R617 at CTO 1199A	ADT	2 683	316	11.8%
		ADLT	2 150	158	7.3%
		ADTT	532	158	29.7%
	R56 at CTO 1106	ADT	7 845	285	3.6%
		ADLT	7 142	148	2.1%
		ADTT	703	137	19.5%

uMWP-1	Location	Description	Background Traffic Volume, per day (two-way)	uMWP-1 Construction Traffic, per day (two-way)	Percentage Increase
	R56 at CTO 1150	ADT	8 084	285	3.5%
		ADLT	7 042	148	2.1%
		ADTT	1 043	137	13.1%
Potable Water Infrastructure	R617 at CTO 1264	ADT	9 292		
		ADLT	8 609		
		ADTT	683		
	R617 at CTO 1199A	ADT	2 683		
		ADLT	2 150		
		ADTT	532		
	R56 at CTO 1106	ADT	7 845	278	3.5%
		ADLT	7 142	146	2.0%
		ADTT	703	132	18.8%
	R56 at CTO 1150	ADT	8 084	278	3.4%
		ADLT	7 042	146	2.1%
		ADTT	1 043	132	12.7%
Total	R617 at CTO 1264	**ADT**	**9 292**	**316**	**3.4%**
		ADLT	8 609	158	1.8%
		ADTT	683	158	23.1%
	R617 at CTO 1199A	**ADT**	**2 683**	**316**	**11.8%**
		ADLT	2 150	158	7.3%
		ADTT	532	158	29.7%
	R56 at CTO 1106	**ADT**	**7 845**	**563**	**7.2%**
		ADLT	7 142	294	4.1%
		ADTT	703	269	38.3%
	R56 at CTO 1150	**ADT**	**8 084**	**563**	**7.0%**
		ADLT	7 042	294	4.2%
		ADTT	1 043	269	25.8%

ADT – Average Daily Traffic

ADLT – Average Daily Light Traffic

ADTT – Average Daily Truck Traffic

Considering the extent of the project the increase in the ADT is low. The project construction phase is expected to be 6 years.

7.1.2 Operational Phase

The number of vehicle trips generated by the uMWP-1 during the operation phase (2024) in relation to the background traffic on the road is given below:

Table 7-2: Operational Phase – Peak Traffic Volume Increase (2024)

uMWP-1	Location	Description	Background Traffic Volume, per day (two-way)	uMWP Operational Traffic, per day (two-way)	Percentage
Raw Water Infrastructure	R617 at CTO 1264	ADT	10458	19	0.2%
		ADLT	9690	11	0.1%
		ADTT	769	8	1.0%
	R617 at CTO 1199A	ADT	3020	19	0.6%
		ADLT	2420	11	0.5%
		ADTT	599	8	1.3%
	R56 at CTO 1106	ADT	8830	18	0.2%
		ADLT	8038	10	0.1%
		ADTT	791	8	1.0%
	R56 at CTO 1150	ADT	9099	18	0.2%
		ADLT	7926	10	0.1%
		ADTT	1174	8	0.7%
Potable Water Infrastructure	R617 at CTO 1264	ADT	10458	0	0.0%
		ADLT	9690	0	0.0%
		ADTT	769	0	0.0%
	R617 at CTO 1199A	ADT	3020	0	0.0%
		ADLT	2420	0	0.0%
		ADTT	599	0	0.0%
	R56 at CTO 1106	ADT	8830	37	0.4%
		ADLT	8038	31	0.4%
		ADTT	791	6	0.8%
	R56 at CTO 1150	ADT	9099	37	0.4%
		ADLT	7926	31	0.4%
		ADTT	1174	6	0.5%
Total	R617 at CTO 1264	**ADT**	**10458**	**19**	**0.2%**
		ADLT	9690	11	0.1%
		ADTT	769	8	1.0%
	R617 at CTO 1199A	**ADT**	**3020**	**19**	**0.6%**
		ADLT	2420	11	0.5%
		ADTT	599	8	1.3%
	R56 at CTO 1106	**ADT**	**8830**	**55**	**0.6%**
		ADLT	8038	41	0.5%
		ADTT	791	14	1.8%
	R56 at CTO 1150	**ADT**	**9099**	**55**	**0.6%**
		ADLT	7926	41	0.5%
		ADTT	1174	14	1.2%

ADT – Average Daily Traffic, ADLT – Average Daily Light Traffic, ADTT – Average Daily Truck Traffic

The increase in traffic volumes during the operational phase is calculated to be ±1% as indicated in the table above. The traffic impact on the local road network during the operation phase is almost negligible.

7.2 Traffic Assignment

Vehicle trips will be made for the delivery and moving of construction material as well as by the workforce. These trips will take place between commercial construction material sources, site delivery hubs and Pietermaritzburg.

The vehicle trips as calculated in **Section 6** were assigned onto the road network according to the assumed origin and destination pairs. The trip assignment for the construction phase was done for a normal weekday AM peak hour and a Friday month end PM peak hour. The trip assignment for the operation phase was done for a normal weekday AM and PM peak hour. These are expected to be the periods when peak traffic will be generated by the uMWP-1.

A daily trip generation was calculated for the delivery and moving of construction material. It was assumed that these trips will be uniformly distributed from 8h00 – 16h00 in order to calculate the AM and PM peak hour trips. In reality there is likely to be less heavy vehicle traffic during the commuter peaks than during midday, hence the impact on the peak hour traffic operation is over-estimated. The trip generation for the workforce was calculated for the AM and PM peak.

The position for the Water Treatment Plant has yet to be finalised, but 3 alternatives were identified – see **Figure 3**. Option 1 is located close to Langa dam and will take access through the R56 / P334 and R56 / Baynesfield 2 intersections. Option 2 is located very close to the R56 and will take access directly from the R56. Option 3 is located east of the R624 and will take access from the R56 via Umlaas Rd (R603) connecting to the R624. The water treatment plant is expected to only generate 26 heavy vehicle trips on a critical day during the peak construction period (see **Table 6-7**) and 27 vehicle trips during the AM and PM peak hour in the operational phase (see **Table 6-10**). Option 1 was considered to be the most critical traffic scenario as all generated traffic is then concentrated at the same point. Option 2 and 3 were therefore not analysed as part of the traffic study.

The trip assignment is illustrated on **Figure 6 (a & b) and 7 (a & b)**.

7.3 Operational Analysis Results

7.3.1 Construction Phase

The construction period ranges over more than one year and is expected to start in 2018. It is anticipated that the traffic generation owing to construction will peak in 2020.

The following scenarios were analysed:

1. **Weekday AM peak**
   - Base year with no uMWP-1 traffic (2018);
   - Critical construction year with no uMWP-1 traffic (2020); and
   - Critical construction year with uMWP-1 traffic (2020).
2. **Friday month-end PM peak**
   - Base year with no uMWP-1 traffic (2018);
   - Critical construction year with no uMWP-1 traffic (2020); and
   - Critical construction year with uMWP-1 traffic (2020).

The scenarios were selected based on the following:

- It was assumed that heavy vehicle deliveries will be uniformly spread over weekdays from 08h00 – 16h00. During the weekday AM peak these volumes will be combined with professional employees travelling to site.
- Skilled staff will reside in the construction camps on site. On the last Friday of every month all workers will go home for the weekend.
- The base year (2018) is analysed to determine what the road conditions will be before commencement of any construction.
- A future year (2020) when construction traffic is expected to peak is analysed without and with construction traffic to determine the maximum impact of the construction traffic

The manual traffic counts were conducted on a normal weekday (**Section 3.2**). Based on the electronic data (R617 & R56) the Friday PM peak for light vehicles is ±30% higher than for a normal weekday PM peak. The background volumes were increased accordingly.

The critical intersections are all 1-way stop controlled intersections with free flow conditions on the R617 and R56.

The aaSIDRA for Windows Software Package(ref 2) was used to determine the current volume over capacity ratios (V/C) and levels of service (LOS) with regard to the delay experienced at each intersection. The software evaluates and measures an intersection's capacity in accordance with the Highway Capacity Manual(ref 4). The output of the analysis is given as levels of service (LOS) which are based on the average delay experienced and range from A, very good with minimum delay, to F, very bad with unacceptable delays. The V/C ratios depict the volume of vehicles in relation to the available road capacity, where values greater than 0.95 indicate insufficient capacity to accommodate vehicles, resulting in excessive queues and delay.

The operational analyses were done for the 5 critical intersections (see **Figure 2**) and the results are summarised in **Table 7-3** below:

Table 7-3: Construction Phase – Intersection Operational Analyses Results

Scenario	Operation measure	R617 / Access Road to Smithfield Main Dam Embankment	R617 / Mdayane Access Road	R617 / D1212 (Nonguqa Access Road)	R56 / P334	R56 / Baynesfield 2
Weekday AM Peak						
2018 (base year)	**Delay**	1.00	0.50	0.50	1.30	0.90
	V/C	0.04	0.05	0.05	0.15	0.18
	LOS	B	B	B	B	B
2020 (no uMWP-1)	**Delay**	1.00	0.50	0.50	1.40	0.90
	V/C	0.04	0.05	0.05	0.15	0.19
	LOS	B	B	B	B	C
2020 (with uMWP-1)	**Delay**	5.10	0.50	0.50	4.00	4.20
	V/C	0.09	0.05	0.05	0.23	0.30
	LOS	B	B	B	C	B
Friday month end PM Peak						
2018 (base year)	**Delay**	1.10	0.60	0.70	1.80	2.00
	V/C	0.06	0.07	0.07	0.22	0.22
	LOS	B	B	B	C	C
2020 (no uMWP-1)	**Delay**	1.10	0.70	0.80	1.90	2.10
	V/C	0.07	0.07	0.07	0.24	0.23
	LOS	B	B	B	C	C
2020 (with uMWP-1)	**Delay**	4.10	0.70	0.70	5.00	5.10
	V/C	0.10	0.07	0.07	0.32	0.33
	LOS	B	B	B	C	C

Delay in seconds, v/c – volume over capacity, LOS – level of service

All the intersections operate at an acceptable LOS with ample spare capacity. The delay and V/C increases only marginally. No traffic capacity problems are foreseen at any of the critical intersections.

It is, however, recommended that additional signage be provided at the R617 / Smithfield Main Dam Embankment Access Road intersection to indicate turning heavy vehicles with point duty flagmen to ensure adequate traffic safety owing to the poor sight distance.

7.3.2 Operational Phase

The construction phase is expected to be completed by 2023. It is therefore anticipated that the operational traffic will start in 2024.

The following scenarios were analysed:

1. **Weekday AM peak**
   - Operational year with no uMWP-1 traffic (2024); and
   - Operational year with uMWP-1 traffic (2024).
2. **Weekday PM peak**
   - Operational year with no uMWP-1 traffic (2024); and
   - Operational year with uMWP-1 traffic (2024).

The scenarios were selected based on the following:

- The traffic generated by the operational phase mainly consists of employees travelling to and from work.
- It was assumed that heavy vehicle deliveries will be uniformly spread over a day from 08h00 – 16h00. During the weekday AM and PM peak these volumes will be combined with the employees travelling to and from work.

The operational analyses were done for the 5 critical intersections (see **Figure 2**) and the results are summarised in **Table 7-4** below:

Table 7-4: Operational Phase – Intersection Operational Analyses Results

Scenario	Operation measure	R617 / Access Road to Smithfield Main Dam Embankment	R617 / Mdayane Access Rd	R617 / D1212 (Nonguqa Access Rd)	R56 / P334	R56 / Baynesfield 2
Weekday AM Peak						
2024 (no uMWP-1)	**Delay**	1.0	0.6	0.6	1.5	1.0
	V/C	0.05	0.05	0.06	0.17	0.21
	LOS	B	B	B	C	C
2024 (with uMWP-1)	**Delay**	1.5	0.6	0.6	2.0	1.7
	V/C	0.05	0.05	0.06	0.18	0.23
	LOS	B	B	B	C	B
Weekday PM Peak						
2024 (no uMWP-1)	**Delay**	1.0	0.6	0.7	1.8	1.8
	V/C	0.06	0.07	0.07	0.21	0.21
	LOS	B	B	B	C	C
2024 (with uMWP-1)	**Delay**	1.5	0.6	0.7	2.2	2.1
	V/C	0.07	0.07	0.07	0.22	0.21
	LOS	B	B	B	C	C

All the intersections operate at an acceptable LOS with ample spare capacity. The delay and V/C increases only marginally. No traffic capacity problems are foreseen at any of the critical intersections.

7.4 IMPACT ON PAVEMENT CONSUMPTION

The additional E80s that will be added to the road by the uMWP-1 during the construction period was calculated. The average E80s per heavy vehicle was calculated using the assumed average payload of 30 t (see **Section 6.1.2**) that can be transported by an efficiently loaded 6-axle truck. The calculations were done for the critical southbound lane as it carries more load than the northbound lane. The results are summarised below:

Table 7-5: Construction Phase – E80 (million)

Year	R617 Southbound		R56 Southbound	
	Background E80	uMWP-1 added E80	Background E80	uMWP-1 added E80
2018	0.13	0.01	0.16	0.02
2019	0.13	0.04	0.16	0.03
2020	0.13	0.06	0.16	0.07
2021	0.14	0.04	0.17	0.07
2022	0.14	0.01	0.17	0.03
2023	0.15	0.00	0.18	0.00
TOTAL	**0.94**	**0.16**	**1.14**	**0.23**

The E80s on the R617 and R56 is increases by 17% and 20% respectively. The percentage increase in E80's was only calculated over the 6-year period while a pavement's design life is typically 20 or 30 years. The percentage of the design load that is consumed is thus proportionally less than the 17% and 20%.

The additional traffic over the construction phase will increase the deterioration of the R617 and R56 pavements and will therefore require increased maintenance from the road authority. It must, however, be taken into account that the additional heavy vehicle trips owing to construction will only be present for 6 years. The negative impact on road deterioration is considered to be low on both the R617 and R56.

The increase in E80s during the operational phase is negligible.

7.5 Traffic Through Built-up Areas

The impact of the marginally increased traffic volumes on the R617 and R56 will have a minor impact on settlements along these routes. Sensitive locations that will be impacted by the increased traffic volumes are listed below:

- Baynesfield Estate
- Mkheshekeni Settlement

The access road to the middle of the tunnel is a gravel road along the western border of the Mkheshekeni settlement. The TBM is expected to be transported along this route. The concrete lining for the tunnel will also be transported from Smithfield dam along this route. On Friday month end the workforce at the tunnel will be transported along this route. It must be kept in mind that these trips are not all on a regular basis and will not occur for extended periods.

Construction material will be imported via the access road to Langa dam passing north of the Baynesfield Estate buildings. It is expected that in 2018 for a 3 month period 260 heavy vehicle trips (two-way) will be generated daily on this road. It must be kept in mind that the trips are uniformly spread over a period of 8 hours each day resulting in 33 heavy vehicles per hour on a critical day. From 2019 to 2022 108 heavy vehicle trips (two-way) will be generated daily on this road resulting in an average of 14 heavy vehicles per hour on a critical day.

8 MITIGATION MEASURES

The construction phase is expected to start in 2018 and be completed in 2023. The operation phase will thus start in 2024.

Based on the operational analyses (see **Section 7.3**) the critical intersections are expected to operate at an acceptable level of service during the peak periods. It is thus expected that if traffic related issues arise it will be owing to road safety issues and social impact. Based on best practise the following mitigation measures are proposed:

- Strict adherence to speed limits by construction vehicles on the R617, R56 and access roads. Appropriate speed limits need to be posted on all access roads according to the geometric design and limitations of heavy vehicles.
- The access roads need to provide sufficient width for heavy vehicles to navigate around curves in the road.
- All uMWP-1 associated heavy vehicles may only use the designated access routes (see **Figure 2 and 3**).
- It is expected that heavy vehicles will have to cross the R617 with construction of the R617 deviation. When construction vehicles are required to cross the R617 or R56 appropriate safety and traffic calming measures need to be in place. This will include flag men, speed reductions and warning signage.
- Where construction of a pipeline crosses the R56 appropriate safety measures need to be in place to prevent and safeguard crossing of the road as applicable.
- The payloads delivered by heavy vehicles need to be recorded and audited to prevent overloading of heavy vehicles.
- Abnormal load permits must be acquired for the transport of abnormal loads.
- Traffic accommodation to South-African Road Traffic Signs Manual standards where any construction affects an existing road.
- Time restrictions for delivery vehicles through built-up and socially sensitive areas.

From a road maintenance point of view:

- Based on the observed condition of the R617 and R56 pavement (see **Section 4.4**) it is recommended that a more detailed pavement investigation be done to determine the pavement condition to refine the pavement maintenance action plan for the construction phase.

- To reduce the impact and prevent dust clouds the access road to Langa dam at Baynesfield Estate as well as the access road to the Smithfield main dam embankment needs to be paved.

9 ENVIRONMENTAL MANAGEMENT PLAN

It is recommended that the mitigation measures provided in **Section 8** be included in the EMP. It is further recommended that the traffic impact be monitored and adherence to the EMP confirmed through the following actions:

1. Baseline traffic monitoring, 1 year ahead of construction, to confirm the traffic status quo on the road links that are to be worst affected.

2. Traffic Monitoring during the construction period, to confirm whether the traffic increase is similar to forecasted increase, whether the contractor complies with activity time restrictions, whether posted speed limits are adhered to, etc.

3. Traffic monitoring after completion of construction (operation phase), 6 months after construction to confirm the new level of traffic resulting from normal operations.

4. Overloading Management through auditing of bulk construction material delivery slips to ensure high-level adherence to current legislation.

5. Monitoring of dangerous locations (eg. truck crossings, schools, road diversions etc.) and adjusting the mitigation measures as appropriate.

The EMP should be updated as appropriate during the project. Evidence of the actual impact on the local road network as well as the effect of implemented mitigation measures can then be readily made available.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

Based on the investigation the following conclusions are made:

Road Network

- The uMWP-1 will mainly influence the provincial routes R617 and R56. In 2014 the R617 had an ADT of ±7 800 and ADTT of ±600 and the R56 had an ADT of ±6 500 and ADTT of ±600.
- 5 critical intersections were investigated. These intersections are all uMWP-1 access routes as well as routes influenced by route deviations that intersect with the R617 and R56. The traffic volumes at the critical intersections consist mostly of through traffic on the R617 and R56, the intersections all have low traffic volumes making turning movements. Low pedestrian and cyclist volumes are present at all of the intersections.

Construction Phase

- It is expected that the skilled staff will reside in the construction camps on site during the construction period and only go home on the last Friday of the month. Professional staff and local labour will travel to and from work on a daily basis.
- It is expected that for the construction a high proportion of the construction material will be sourced from the dam basins and tunnel. A smaller percentage of the required construction material will thus be imported to site from commercial sources.
- It is expected that the peak trip generation will be in 2020 during the construction phase. 320 light vehicle trips and 300 heavy vehicle trips will be generated during the weekday AM peak. 385 light vehicle trips and 270 heavy vehicle trips will be generated during the Friday month-end PM peak. The traffic assignment to the road network is illustrated on **Figure 6a and b**.
- The ADT in 2020 for the R617 and R56 is expected to increase by ±10% and ±7% respectively. The ADTT in 2020 for the R617 and R56 is expected to increase by ±30% and ±40% respectively.
- All of the critical intersections are expected to operate at an acceptable LOS with ample spare capacity.

- The E80s on the R617 and R56 is increases by 17% and 20% respectively over the 6-year construction period.

Operational Phase

- Additional vehicle trips will be added to the road network during the operational phase owing to employees travelling to and from work, sludge removal and delivery of chemicals.
- Approximately 60 light vehicle trips and 40 heavy vehicle trips will be generated during the weekday AM peak. 60 light vehicle trips and 40 heavy vehicle trips will be generated during the weekday PM peak. The traffic assignment to the road network is illustrated on **Figure 7a and b**.
- An operational analysis was performed for each of the critical intersections in the first year of operation (2024) and all 5 intersections are expected to operate at an acceptable LOS with ample spare capacity.

Impact Management

- Mitigation measures were developed in order to reduce the impact of the uMWP-1 on the surrounding road network. The mitigation measures are contained in **Section 8** of this report.
- The public participation process has not commenced. This report will be updated based on feedback received and additional issues raised during this process.

10.2 Recommendations

It is recommended that:

- Additional signage be provided to indicate turning heavy vehicles with point duty flag men at the R617 / Smithfield Main Dam Embankment Access Road intersection to ensure adequate traffic safety owing to the poor sight distance.
- A more detailed pavement investigation be done to determine the current pavement condition and if earlier maintenance will be required owing to the increase cumulative E80s over the construction period.
- Monitoring and management actions be set in place in order to ensure adherence to the EMP, pertaining to traffic, can be enforced and monitored.
- The traffic impact study be revised with appointment of the contractor when more detailed information will be available.

11 REFERENCES

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3. Umgeni Water, Knight Piésold Consulting, Water Treatment Works Conceptual Design and Cost Estimates, uMkhomazi Water Project Module 3 – Water Works Design, October 2014.
4. Transportation Research Board: National Research Council, Highway Capacity Manual. 2000. Washington D.C
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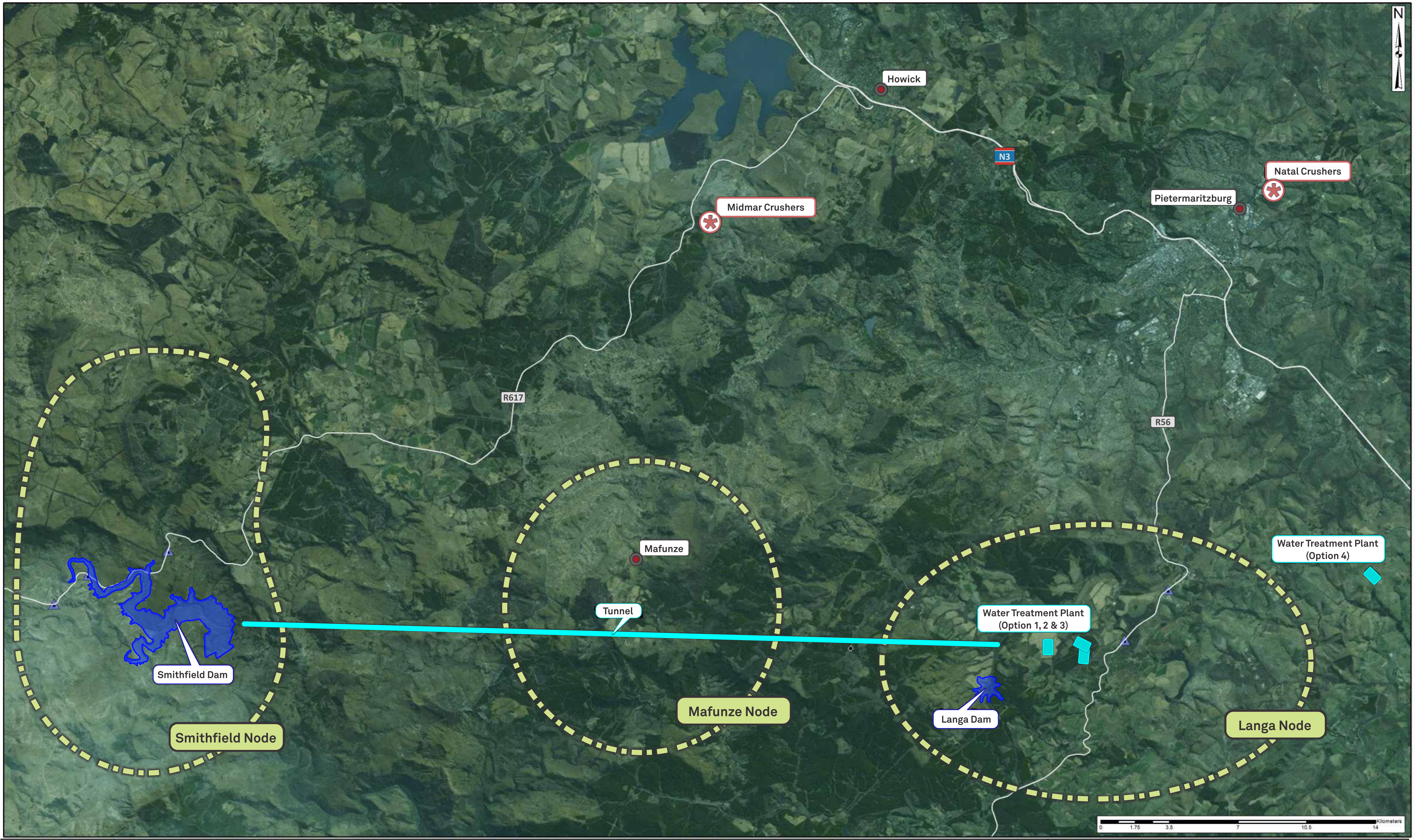

Project Title:	Traffic Impact Assessment: The Umkhomazi Water Project Phase 1
Map Title:	**Study Area**

Scale 1:175,000
(When page size is: A3 landscape)

Figure 1

Projection: Geographic
Datum: Hartebeesthoek 1994

Compiled By: L Kros
GIS QC By:
Approved By: C van Wyk
Date Saved: 4/17/2015
Project Number: J01763
Map Ref: StudyAreaA3L for Fig 1.mxd
Revision: 0

Sources:

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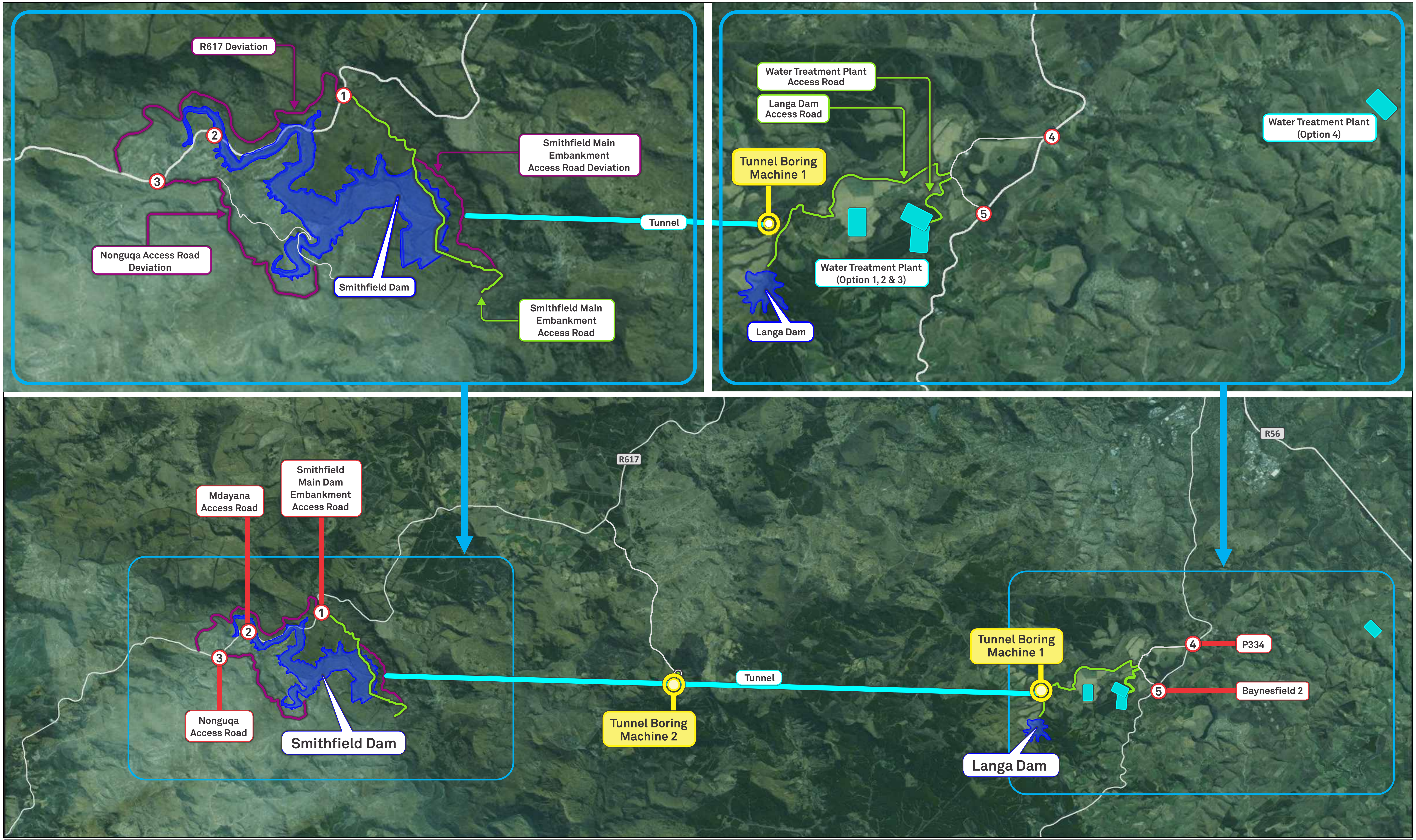

Project Title:	Traffic Impact Assessment: The Umkhomazi Water Project Phase 1
Map Title:	Access Routes, RoadDeviations and TBM Positions

Scale 1:200,000
(When page size is: A3 landscape)

Figure 2

Projection: Geographic
Datum: Hartebeesthoek 1994

Compiled By: L Kros
GIS QC By:
Approved By: C van Wyk
Date Saved: 4/22/2015
Project Number: J01763
Map Ref: StudyAreaA3L Fig2 New.mxd
Revision: 0

LEGEND

(1) - Critical Intersections

AECOM

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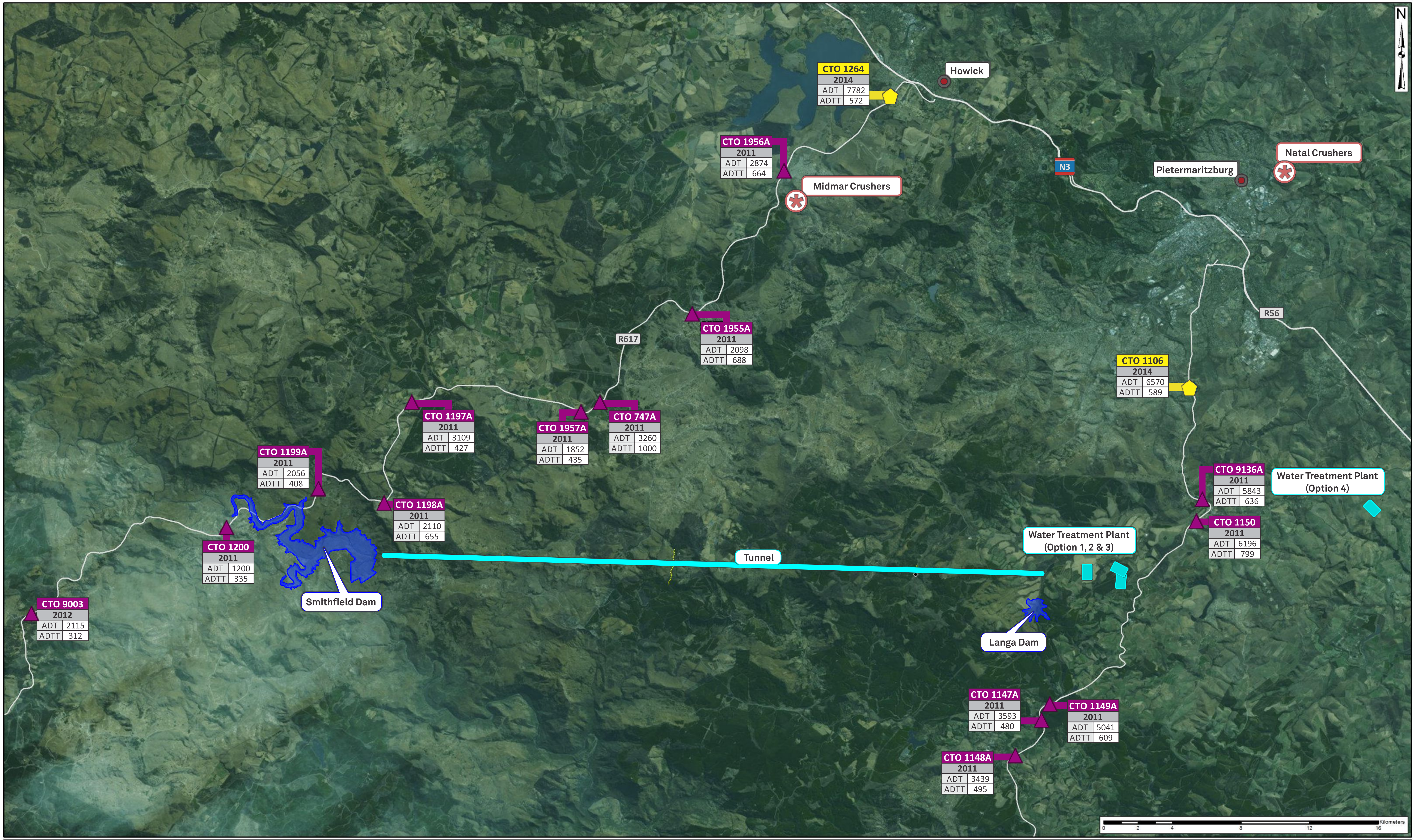

Project Title:	Traffic Impact Assessment: The Umkhomazi Water Project Phase 1	Scale 1:200,000 (When page size is: A3 landscape)	Figure 3
Map Title:	**Electronic Traffic Surveys**	Projection: Geographic Datum: Hartebeesthoek 1994 Compiled By: L Kros GIS QC By: Approved By: C van Wyk Date Saved: 4/22/2015 Project Number: J01763 Map Ref: StudyAreaA3L Fig3.mxd Revision: 0	Sources:

Whilst every care has been taken in compiling the information on this map, AECOM cannot accept responsibility for any inaccuracies.

AECOM

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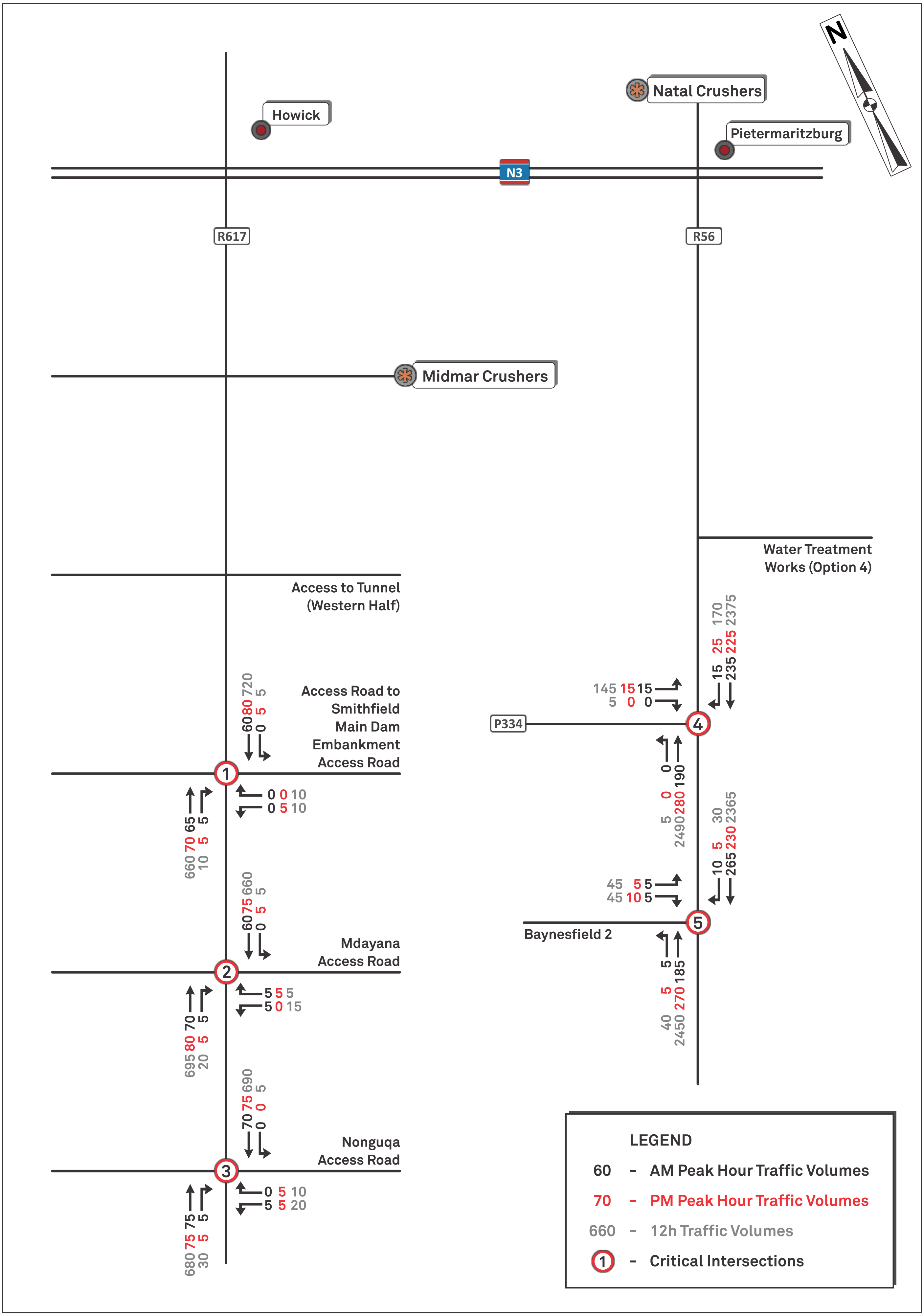
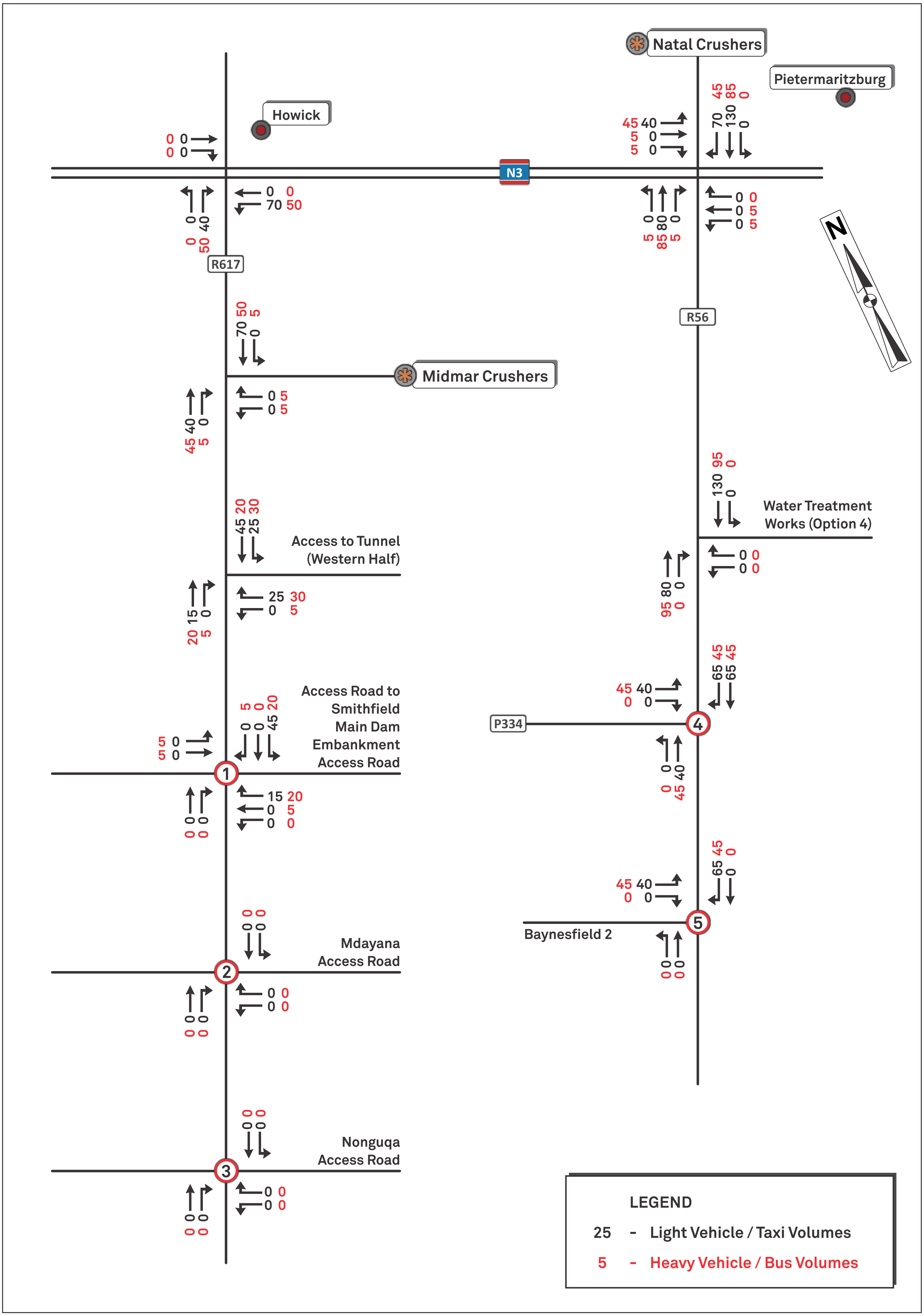
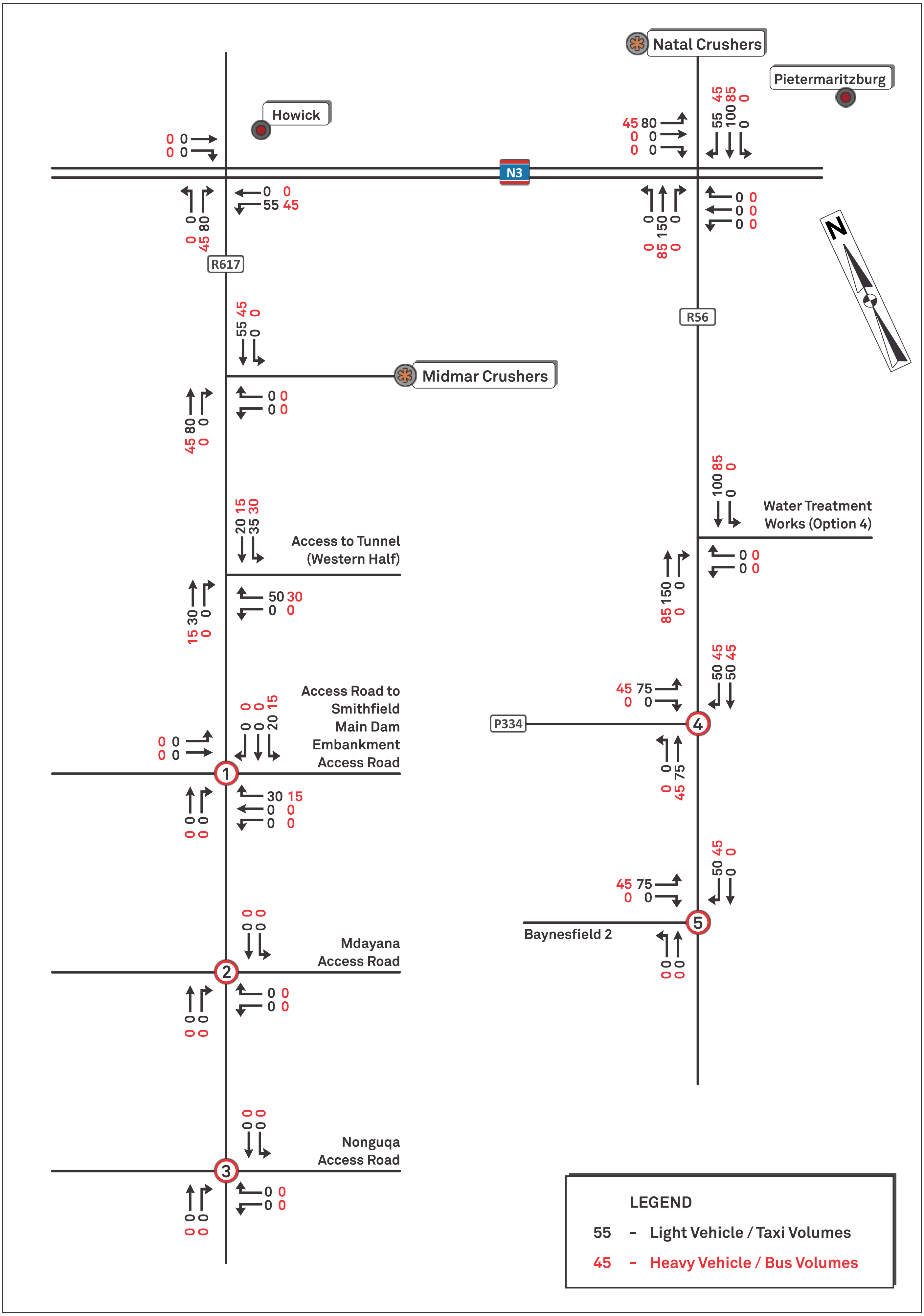

N
Howick
Natal Crushers
Pietermaritzburg
N3
R617
R56
Midmar Crushers
Water Treatment Works (Option 4)
Access to Tunnel (Western Half)
Access Road to Smithfield Main Dam Embankment Access Road
P334
Baynesfield 2
Mdayana Access Road
Nonguqa Access Road
LEGEND
60 - AM Peak Hour Traffic Volumes
70 - PM Peak Hour Traffic Volumes
660 - 12h Traffic Volumes
1 - Critical Intersections


Natal Crushers
Pietermaritzburg
Howick
N3
R617
R56
Midmar Crushers
Water Treatment Works (Option 4)
Access to Tunnel (Western Half)
Access Road to Smithfield Main Dam Embankment Access Road
P334
Baynesfield 2
Mdayana Access Road
Nonguqa Access Road
N
LEGEND
25 - Light Vehicle / Taxi Volumes
5 - Heavy Vehicle / Bus Volumes



CvW/0005D/2015 (J01763)

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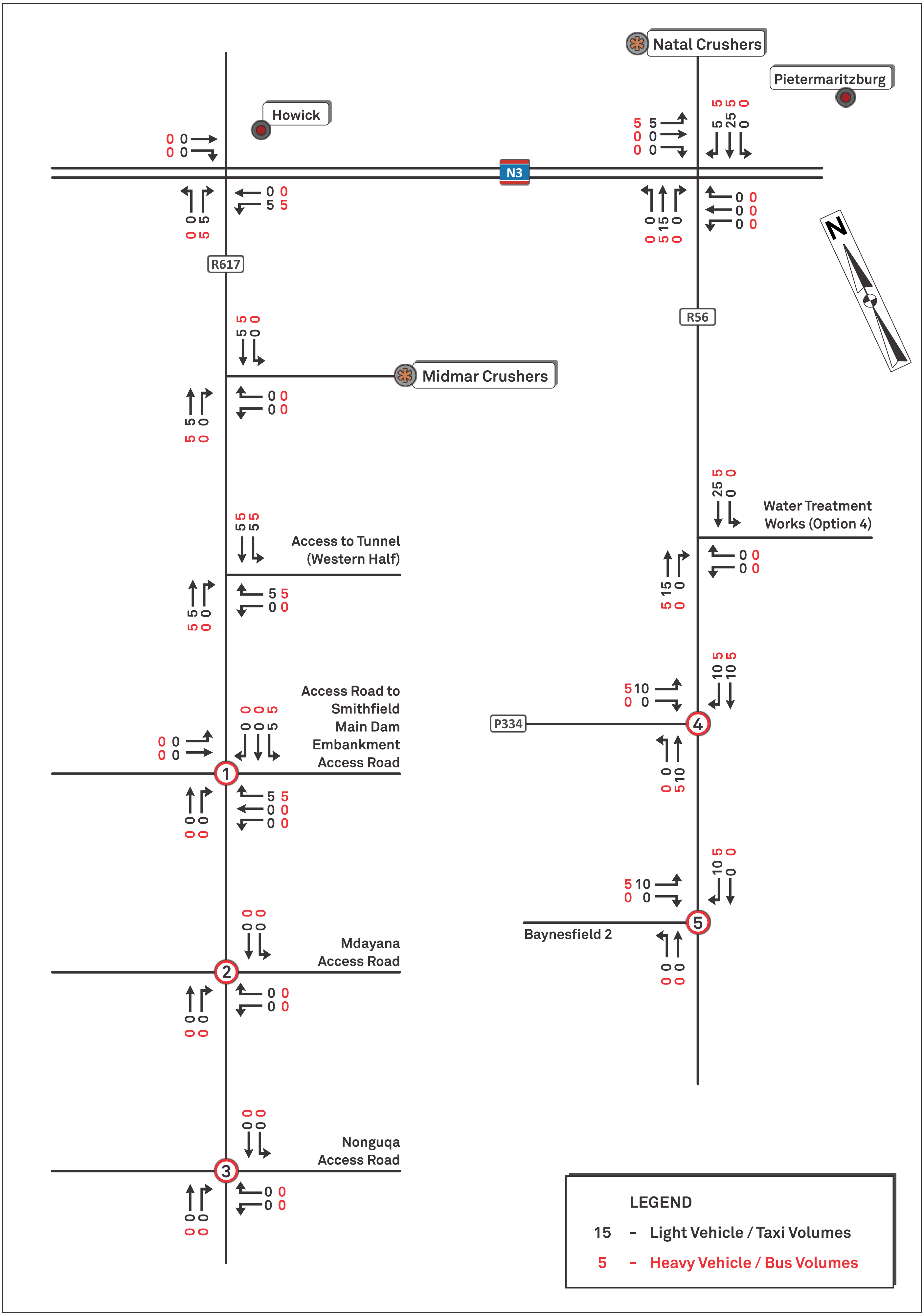
TRAFFIC IMPACT ASSESSMENT:
THE UMKHOMAZI WATER PROJECT PHASE 1

Construction Phase: Trip Generation
(2020) Friday Month-end PM Peak Hour

5b

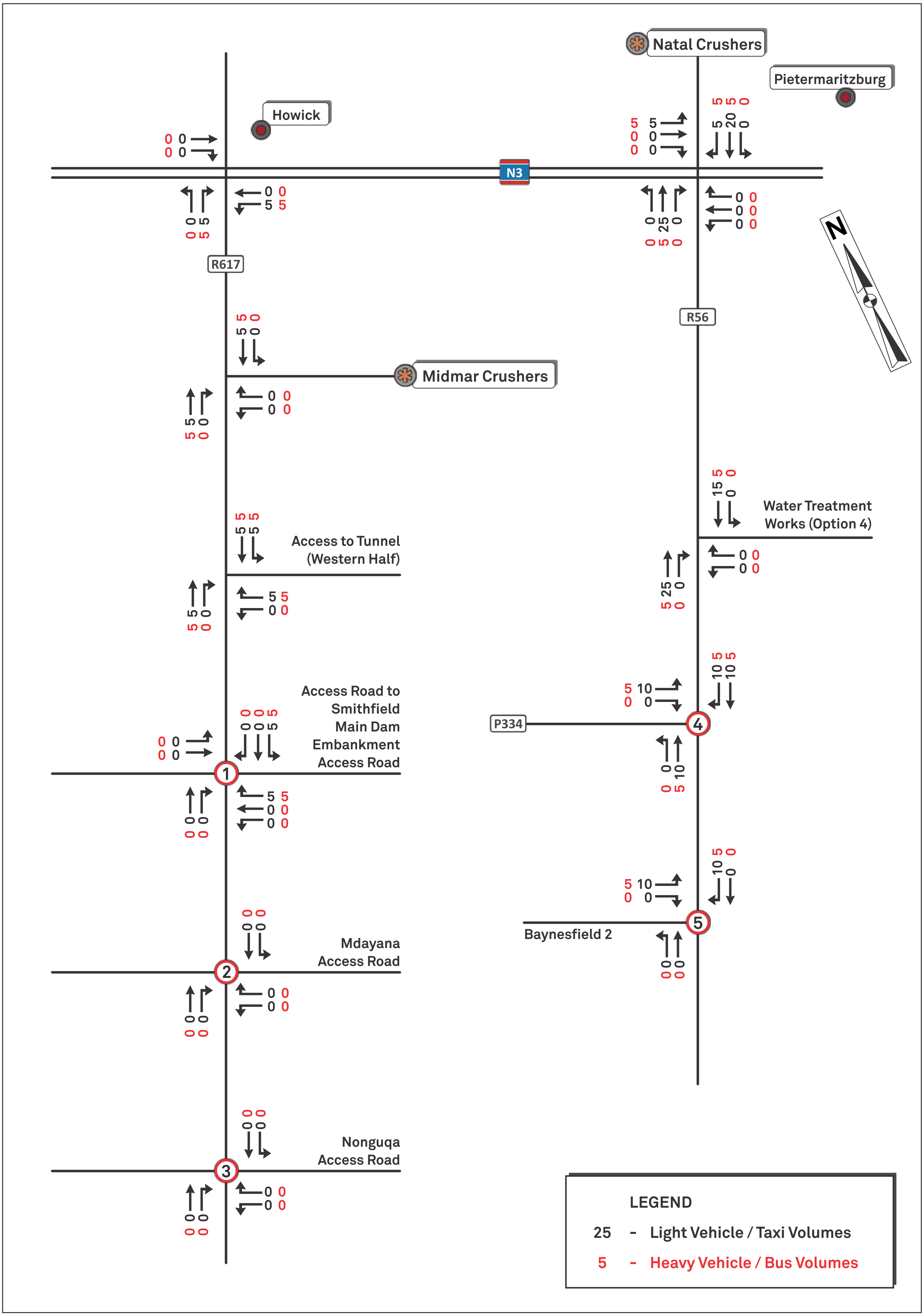


CvW/0006D/2015 (J01763)

TRAFFIC IMPACT ASSESSMENT:
THE UMKHOMAZI WATER PROJECT PHASE 1

Operation Phase: Trip Generation (2024) AM Peak Hour

6a



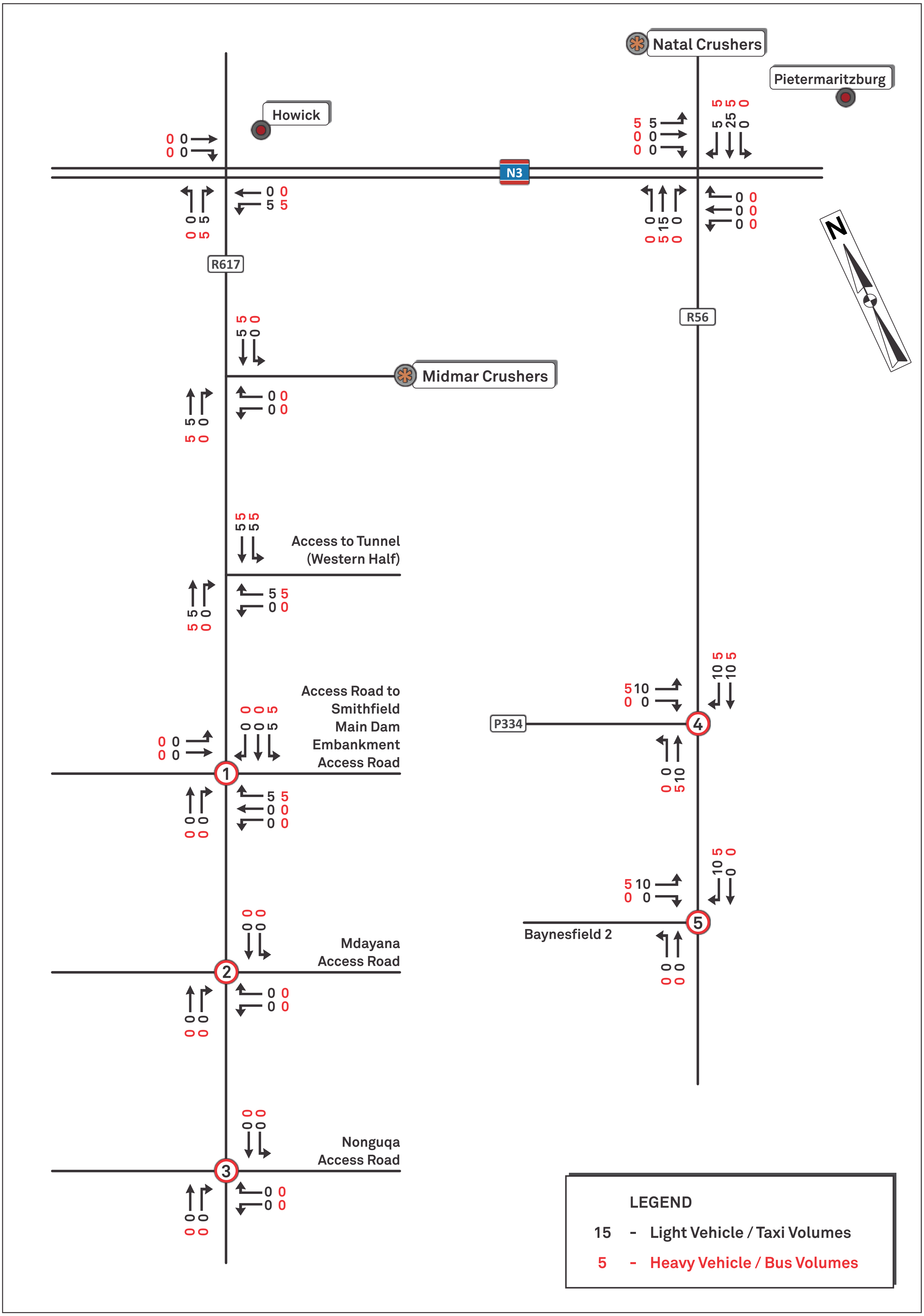
CvW/0006D/2015 (J01763)

AECOM

TRAFFIC IMPACT ASSESSMENT:
THE UMKHOMAZI WATER PROJECT PHASE 1

Operation Phase: Trip Generation
(2024) PM Peak Hour

6b



CvW/0006D/2015 (J01763)

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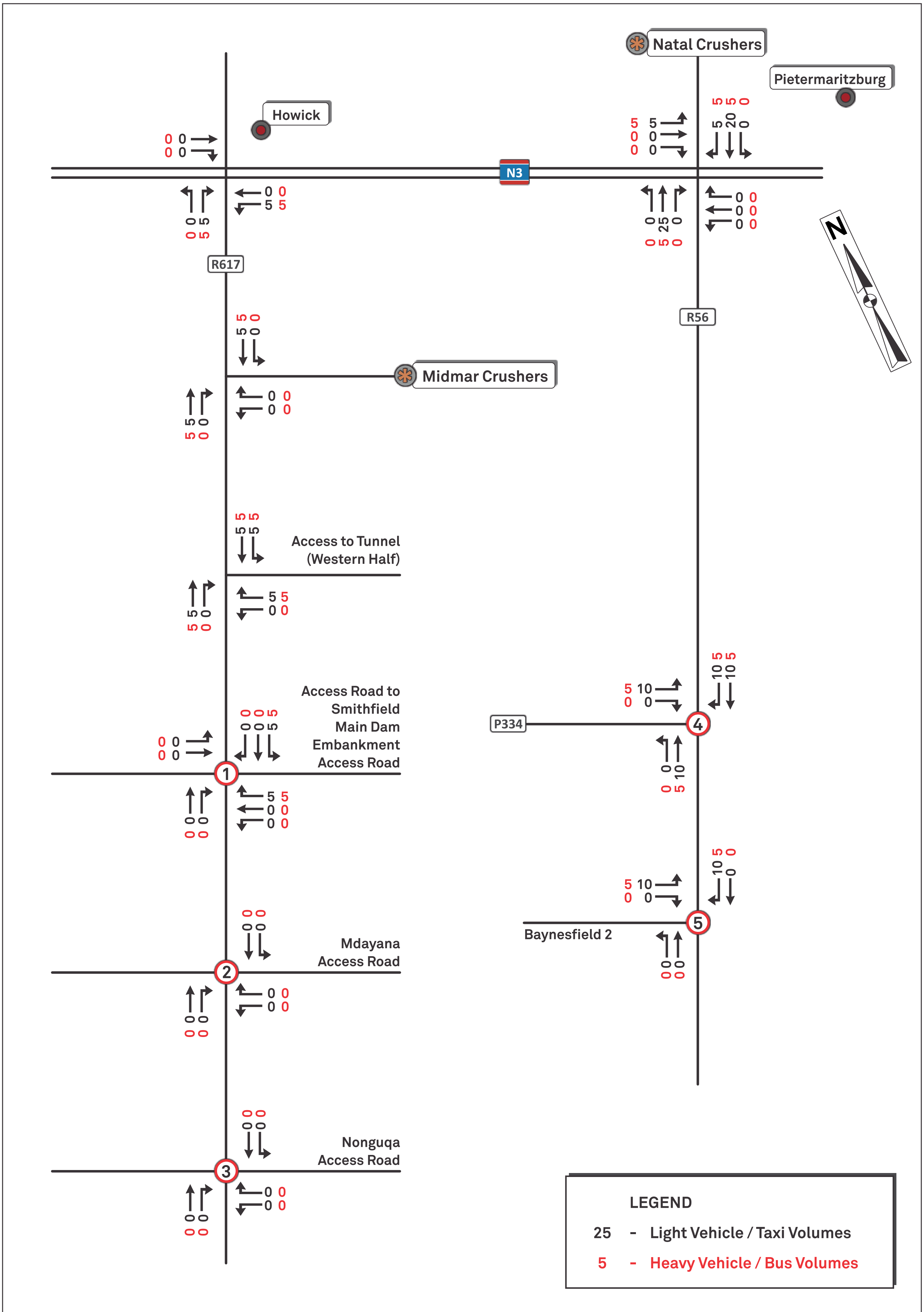
TRAFFIC IMPACT ASSESSMENT:
THE UMKHOMAZI WATER PROJECT PHASE 1

Operation Phase: Trip Generation
(2024) AM Peak Hour

7a



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Appendix A

Construction Material Quantities

uMWP	Imported & Transported Material						Imported & Transported Material						Total Tonnage (excl pipes)	Total Payloads	Construction Period				Avg Deliveries / day in peak
	Sand (m³)	ggregate (m	Cement (m³)	inforcement	cavation (m	Pipe (m)	Sand (t)	Aggregate (t	Cement (t)	inforcement	xcavation (t	Pipe (m)			From	To	Nr. Months		
Smithfield (Raw Water Project)																			
Access roads - smithfield		26 683						40 025					40 025	1 334	Oct-18	Dec-18	3		20
Smithfield Dam & Tunnel	253 252		33 801	22 411			354 552		50 701	22 411			427 665	14 255	Oct-18	May-22	44		18
R617 deviation		17 883						26 825					26 825	894	Jul-19	Dec-20	18		3
Smithfield Dam to R617 deviation		51 661						77 491					77 491	2 583	Jul-19	Dec-20	18		8
Smithfield Dam from/to Tunnel (western half)	29 231	34 955	11 692	5 036			40 923	52 432	17 538	5 036			115 929	3 864	Nov-19	Feb-22	28		8
Langa (Raw Water Project)																			
Access roads - langa		71 288						106 932					106 932	3 564	Oct-18	Dec-18	3		54
Langa Dam & Tunnel & raw water pipeline	44 238	245 874	17 725	8 958		5 234	61 934	368 811	26 588	8 958		5 234	466 291	15 543	Apr-19	Jun-22	39		22
Langa Dam from/to Tunnel (eastern half)	29 231	34 955	11 692	5 036	752 905		40 923	52 432	17 538	5 036	1 129 358		1 245 287	49 039	Nov-19	Jun-22	32		84
Water Treatment Works (Potable Water Project)																			
Water Treatment Plant	100 569	65 865	20 612	10 334			140 796	98 798	30 918	10 334			280 846	9 362	Apr-19	Jun-23	51		10
Potable Water Pipeline	194 269					21 873	271 976					21 873	271 976	9 066	Jan-20	Dec-21	24		21

#1 30t payload, 25t payload for excavation
#2 12m pipe section per truck
#3 22 working days per month